ACCURATE LITERAL TRANSLATION OF PCT INTERNATIONAL APPLICATION PCT/DE2004/001191 AS FILED ON JUNE 7, 2004

Wing, Especially a Carrier Wing of an Airplane, Having an Adaptable Profile

The invention relates to a wing, especially a carrying or lifting wing of an aircraft, with a changeable profile.

In aircraft, especially in high performance aircraft, there is a striving to embody the areas or regions of the wing that are used for the controlling and/or trimming of the aircraft so that on the one hand the guidance of the flow on the wing is aerodynamically as advantageous as possible, and on the other hand the arising loads are distributed as uniformly as possible.

It is therefore the object of the invention to provide a wing, especially carrying wing or lifting wing of an aircraft, with a changeable profile, which is as optimal as possible with respect to aerodynamics and load distribution.

Preferably, the wing with changeable profile shall be suitable for optimizing the lift distribution (trimming), but also for the roll control, in the latter case, shall thus replace conventional ailerons.

This object is achieved by a wing with the characterizing features of the claim 1.

Further, embodiments are recited in the dependent claims.

In the following, example embodiments of the invention are explained in connection with the drawing. It is shown by:

Fig. 1 a perspective schematic view of a lifting wing of an aircraft with changeable profile, in which a wing tip region is adjustable via a flexible region in a direction that includes both a component in the wing chord direction as well as a component in the wingspan direction;

Fig. 2 a top plan view onto the wing shown in Fig. 1;

Fig. 3 an enlarged illustration of the flexible region characterized in Fig. 2;

Fig. 4 a section through the flexible region and the wing tip region of the lifting wing shown in the Figs. 1 to 3 according to a first example embodiment of the invention;

Fig. 5 a section through the flexible region of a lifting wing according to a further example embodiment of the invention, in which the flexible region is formed by several box elements that are extended or elongated in a longitudinal direction and arranged between the

first cover skin or covering and the second cover skin or covering of the wing;

Fig. 6 an enlarged illustration that shows an embodiment of a jointed connection between the mentioned box elements and the first cover skin of the lifting wing according to the Fig. 5;

Fig. 7 an enlarged sectional view that shows a detail of a wing construction according to a different example embodiment of the invention;

Fig. 8 a schematic enlarged sectional view of a detail of a drive for adjusting the flexible wing region; and

Figs. 9 and 10

sectional views of spacers or spacing holders, which hold the first cover skin and the second cover skin of a lifting wing at a prescribed spacing distance, and simultaneously allow a relative sliding displacement of the two in a prescribed direction.

The perspective illustration of the Fig. 1 shows a lifting wing 1 of an aircraft, namely of a high performance aircraft, with a changeable profile. The arrow referenced with the reference number 5 means the wing chord direction, which extends essentially in the flow direction, and the arrow referenced with the reference number 10 means the wingspan direction extending

crosswise or perpendicularly thereto. The profile sections 16 shown in Fig. 1 extend parallel to the wing chord direction 5. With reference to the wing chord direction 5, there is a leading edge region 11 and a trailing edge region 12, and with reference to the wingspan direction 10, there is a wing tip region 14 at the end of the wing 1.

The wing tip region 14 is connected with the rest of the wing 1 via a flexible region 15, and is adjustable in a direction that includes both a component in the wing chord direction 5 as well as a component in the wingspan direction 10. As can be seen in the Fig. 1, the flexible region 15 extends obliquely relative to the wing chord direction 5 from the leading edge region 11 to the trailing edge region 12 of the wing 1, and is arranged essentially perpendicularly to the leading edge region 11, which exhibits a marked positive sweepback angle relative to the wing direction 5.

The wing 1 has a first covering or cover skin 55a, namely on its upper side or surface, and a second covering or cover skin 55b lying opposite the first cover skin, namely on its bottom side or surface. In the flexible region 15, the curvature or camber of the wing 1 is adjustable while changing the curvature of the first cover skin 55a and of the second cover skin 55b, whereby both cover skins 55a, 55b exhibit an essentially smooth continuous extension or contour independent of the adjustment.

In the top plan view onto the wing 1 illustrated in Fig. 2, the position of the flexible region 15 is shown more closely, which is shown further enlarged in Fig. 3.

As can be seen in Fig. 3, the flexible region 15 comprises several longitudinally extending torsion boxes 53 arranged next to one another, which extend with their longitudinal direction from the leading edge region 11 to the trailing edge region 12 of the wing 1, thus perpendicularly to the curvature direction of the flexible region 15. As shown by Fig. 4, the torsion boxes 53 are formed of the first cover skin 55a, the second cover skin 55b as well as at least one spar 52 extending in the longitudinal direction of the torsion boxes 53, and are articulately or jointedly connected with one another to a prescribed degree. The torsion boxes 53 are torsionally stiff about their longitudinal direction, yet are changeable or variable in their form or shape, in the sense of a prescribed change of the wing profile, in a direction perpendicular thereto.

An adjusting or actuating mechanism referenced overall with the reference number 60 serves for the changing or varying of the shape or form of the torsion boxes 53, that is to say of the cross-section thereof perpendicular to their longitudinal extension, and therewith of the wing profile in response to a corresponding externally supplied control signal. In detail, the adjusting mechanism 60 includes at least one, and in the example embodiment illustrated in Figs. 3 and 4 a plurality of swivel bodies or vertebra bodies 61, namely a number of swivel bodies

or vertebra bodies 61 that are provided arranged one behind another in the respective torsion boxes 53, as well as respectively a number of swivel bodies or vertebra bodies 61 next to one another in each one of the individual torsion boxes 53.

The vertebra bodies 61 respectively comprise a transmission element 64, which is connected via a pendulum or pivot joint 68 with the first cover skin 55a in order to compensate or even-out a relative motion between the first upper cover skin 55a and the vertebra body 61, and, spaced apart in the vertical direction, a connection location 63 to a drive chord, tendon or line 62a that is adjustable or changeable in its length in response to the control signal.

As can be seen from Fig. 4, each vertebra body 61 in a cross-section has an essentially triangular basic shape, whereby the upper side of the triangle extends essentially parallel to the first upper cover skin 55a and forms the transmission element 64, and the bottom corner or peak of the triangle forms the connection location 63 coupled with the drive chord or line 62a. Thus, a change of the length of the drive line 62a leads to a rotation or twisting of the vertebra body 61 in the sense of a change of the (cross-sectional) shape of the torsion boxes 53, and thus to a change of the wing profile, as is desired. The cooperation of the vertebra bodies 61 and of the drive lines 62a leads to a change of the curvature of the adjusting mechanism 60 formed thereby, as is similar to the change of the curvature in the spinal column of a mammal, for which reason the term

"vertebra body" or "vertebra" is used for the components used with the reference number 61. For the purpose of a further disclosure of the basic principle underlying the adjusting mechanism 60, reference is made to the earlier Patent Application 10055961.1-22, internal file reference P609783SC.

The vertebra or swivel bodies 61 arranged one behind another are respectively connected with one another via a vertebra or swivel joint 69. At the end of the wing tip region 14, there is provided an end piece 77, at which there occurs a compensation of a mutual relative sliding displacement of the first upper cover skin 55a relative to the second lower cover skin 55b with a change of the curvature or camber of the flexible region 15 due to the deformation of the torsion boxes 53. For that purpose, the second lower cover skin 55b is slidably supported against the end piece 77, whereby simultaneously means are provided, by which the cover skin is reliably held onto the end piece 77 in each adjustment position. Alternatively, a compensation of the mutual relative sliding displacement can also take place at a different location.

The pendulum or pivot joint 68 in the example embodiment illustrated in Fig. 4 is embodied as an elastic joint, in which the transmission element 64 of each respective vertebra body 61 is connected via an elastic connection on the one hand with the first cover skin 55a and on the other hand with the associated spar 52. In the illustrated example embodiment, the arrangement of vertebra body 61 and drive line 62a is provided respectively

within the torsion boxes 53, alternatively this can also be provided outside of the same.

In Fig. 5, a further example embodiment of the invention is illustrated.

As shown by the cross-sectional view of Fig. 5, the flexible region 11; 12; 15 comprises several box elements 154, which are connected articulately or jointedly in a prescribed degree at their longitudinal sides at joint regions 169, and are provided between the first cover skin 55a and the second cover skin 55b. The box elements 154 are elongated or extended in a longitudinal direction extending perpendicularly to the plane of the drawing in Fig. 5, and have an essentially triangular basic shape in cross-section.

The box elements 154 are connected with the first cover skin 55a at a transmission region 164, which is formed by the upper base line of the mentioned triangle, and they have, spaced apart in the vertical direction, a connection region 163, which is formed by the corner or peak of the triangle located opposite the baseline, and which is coupled with an adjusting or actuating mechanism referenced overall with the reference number 160, which serves to pivot or tilt the box elements 154 about the joint regions 169 in the sense of a change of the wing profile in response to a corresponding control signal.

The adjusting mechanism 160 comprises a respective drive line 162a, that is changeable in its length and that is coupled with the connection region 163 of the box elements 154, whereby a change of the length of the drive line 162a causes a rotation of the box elements 154 in the sense of a change of the form or shape of the wing profile. The box elements 154 arranged one behind another are respectively coupled with a drive line 162a.

Pendulum or pivot joints 168, which are coupled between the transmission region 164 of the box elements 154 and the first cover skin 55a serve for compensating or evening-out a relative motion between the first cover skin 55a and the box element 154.

As shown by Figs. 6 and 7, which illustrate enlarged sections or portions of the region, in which the box elements 154 are coupled with one another on their longitudinal sides, and on the other hand with the first cover skin 55a of the lifting wing 1, the joint regions 169 and the pendulum or pivot joints 168 are formed by elastic joint elements in the illustrated example embodiments. These elastic joint elements comprise flexibly elastic bands, for example of a spring elastic metal or synthetic plastic, whereby the joint regions 169 and the pendulum or pivot joints 168 are formed by a common element in the illustrated example embodiments. These common elements 168, 169 are formed by flexibly elastic bands 172, 174 that respectively extend in extension of the shanks or legs 154a, 154b of the triangle shaped box elements 154, are fixed or secured thereto on one side, and cross one another, of which the other side is fixed or secured

to the first cover skin 55a of the wing 1. In the space bounded by the flexibly elastic bands 172, 174 crossing one another and the first cover skin 55a, there is provided a filler piece 176, which especially consists of an elastic material, compare Fig. 6.

In the example embodiment illustrated in Fig. 7, there is further provided a web or spar element 177, which extends in the direction from the first cover skin 55a to the second cover skin 55b, and which extends with its longitudinal direction parallel to the longitudinal direction of the box elements 154. This web or spar element 177 is fixed or secured with one side to the first cover skin 55a or near the same on the side of the box elements 154 via a first articulated or jointed connection 178, in the example embodiment illustrated here, on the common joint formed by the joint region 169 and the pendulum or pivot joint 168, and with the other side lying opposite, to the second cover skin 55b, via a second articulated or jointed connection 179. The first articulated or jointed connection 178 and the second articulated or jointed connection 179 are formed by elastic bands.

As shown by Fig. 8, the drive line 162a is coupled via an elastic band 164 with the connection region 163 of the box elements 154.

The Figs. 9 and 10 show cross-sectional views of spacers or spacing holders 181; 281, which are provided between the first cover skin 55a and the second cover skin 55b, by means of which

the cover skins 55a, 55b are held at a prescribed spacing distance and simultaneously a relative motion between these is made possible upon changing of the wing profile.

The spacing holders 181; 281 comprise a roll or drum shaped element 182; 282 and an arrangement of flexible bands 183a, b; 283a, b, through which the roll or drum shaped elements 182; 282 are guided in the sense of a rolling motion between the first cover skin 55a and the second cover skin 55b in connection with a relative motion between these. The flexible bands 183a, b; 283a, b are guided around the roll or drum shaped elements 182; 282 and are secured with their ends on the first cover skin 55a or the second cover skin 55b respectively.

In the example embodiment illustrated in Fig. 9, the flexible band 183a is secured to the first cover skin 55a on the right side of the roll or drum shaped element 182, and is guided around the roll or drum shaped element 182 again back to its right side and is secured to the second cover skin 55b. In a mirror-opposite manner thereto, a further flexible band 183b is secured to the first cover skin 55a on the left side of the roll or drum shaped element 182, guided around the roll or drum shaped element 182 again to its left side and secured to the second cover skin 55b. Thereby, a rolling motion of the roll or drum shaped element 182 between the first cover skin 55a and the second cover skin 55b is possible, and simultaneously the former is securely guided and held.

In the example embodiment illustrated in Fig. 10, the roll or drum shaped element 282 is divided or split in the middle, and each one of the flexible bands 283a, b is guided through the middle of the roll or drum shaped element 282 while reversing the wrapping or winding direction and respectively wrapped or wound in opposite directions around the element 282. Thus, a flexible band 283a is secured to the first cover skin 55a on the left side of the roll or drum shaped element 282, guided around the roll or drum shaped element 282 and back to its left side through the middle thereof, and under reversal of the wrapping or winding direction around the same, is secured to the second cover skin 55b on the right side thereof. A further flexible band 283b is, oppositely, secured to the first cover skin 55a on the right side of the roll or drum shaped element 282, guided around the roll or drum shaped element 282 and back through the middle thereof, and under reversal of the wrapping or winding direction is guided further around the roll or drum shaped element 282 and secured on its left side. Here also, the flexible bands 283a, b allow a relative motion of the cover skins 55a, 55b relative to one another, whereby the roll or drum shaped element 282 is securely guided and held with a rolling motion between the cover skins 55a, 55b.